AERIAL NAVIGATION:

THE PRACTICABILITY OF TRAVELING PLEASANTLY AND SAFELY FROM

NEW-YORK TO CALIFORNIA

IN THREE DAYS,

By RUFUS PORTER,

1849

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FULLY DEMONSTRATED, WITH A FULL DESCRIPTION OF A PERFECT AERIAL LOCOMOTIVE, WITH ESTIMATES OF CAPACITY, SPEED AND COST OF CONSTRUCTION.

By RUFUS PORTER,

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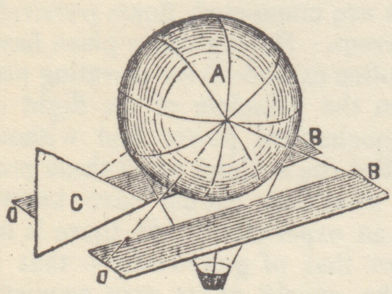
ÆRIAL NAVIGATION.

It has been the expressed opinion of the wisest and most philosophic men of at least two centuries past, that Ærial Navigation was practicable, and would eventually come into practical use. But its introduction has been greatly retarded by the many futile and unscientific pretensions made by visionary persons who had neglected to acquaint themselves with the general and established principles of the true natural (or Newtonian) philosophy. The vague and unreasonable assumption of novices, has had the deleterious effect to destroy or weaken the confidence of wealthy business men in the practicability of travelling with safety through the air. One of these vagaries, which was first introduced by a Mr. Roberts in 1784, and recently revived by a man in New Hampshire, consisted in the foolish idea of directing the motion of a common balloon by means of adjustable sails; the projectors ignorantly overlooking the fact, that no sail could be filled or affected by the wind, while the entire apparatus or vehicle, to which the sails are connected, floats passively along with the ærial current. Several other plans have been projected (and as often exploded) for elevating and propelling a machine on the principle of the flight of birds, by the force of mechanical power and without the aid of buoyancy. But the authors of all these projects have discovered, what they should have known before they attempted an experiment, that there is no power known—not even that of gunpowder— that is capable of sustaining the weight of its own requisite apparatus, by means of either wings or spiral fan-wheels, for any length of time.

Another plan has been proposed, and that by practi-

cal balloonists, who should have known better, for propelling common balloons by steam power. But the projectors of this plan must have been ignorant of the laws of atmospheric resistance; to overcome which would require more than 1,000 horse-powers to a balloon that would carry twenty passengers at the rate of sixty miles an hour; and they must also have overlooked the fact, that with such a velocity, the atmospheric resistance would be sufficient to destroy or rend any material used in ordinary balloons. But the silliest plan that we have seen proposed, was that of Muzzio Muzzi the Italian who raised a considerable excitement on the subject in this (New York) city in 1845, and who, we are grieved to say, managed to obtain the approbation of several gentlemen of high standing and reputation as the first scientific men of New York. We had the pleasure, or rather the mortification, to witness an exhibition of the project of the popular foreigner (and with a fuller house than any native American could draw on a similar occasion), and immediately published in the first number of the "Scientific American," an expose which proved a *killer* to the popular humbug. The following is a copy:—

SIGNOR MUZZI'S TRAVELLING BALLOON.



"This cut sufficiently represents the machine which consists of a balloon or ball (A), made of oiled silk or paper, and filled with hydrogen gas. To this balloon are attached two inclined planes (B B) which are also constructed of light materials and secured in their position by cords. In addition, there is a triangular vane, tale or rudder (C) by which the machine is steered on the principle of a helm. The plan, or mode of operating the machine, is to supply it with a sufficient quan-

tity of gas to cause it to ascend, while the inclined planes, encountering some degree of atmospheric resistance, naturallp shoot off in an oblique direction, drawing the balloon with them. Then, when the machine has ascended to a sufficient height, a part of the gas is to be let off or compressed, so as to cause the balloon to descend, and by a simple contrivance, the position of the two planes is reversed, the depressed ends being brought to the front, they give the balloon an oblique direction in its descent. Thus, by ascending a mile and again descending, a mile of horizontal distance is gained; and if the atmosphere be entirely calm, a mile may be travelled about as quick as a lame man would walk the same distance. But if there be the least breeze of head wind, the game is up. And by what means the balloon is to be made to again ascend, without a fresh supply of gas, the inventor has not informed us—perhaps he does not exactly know.

Such, gentle reader, is the invention which has been lauded by our first men and biggest editors, and of which an awkward model has received "rounds of applause" from a "select and fashionable audience" (who paid fifty cents each to witness the wonder,) as the nearest approach to successful ærial navigation that has ever been thought of, notwithstanding that ten years ago, in a popular public journal of this city,—and again four years ago, in another city paper,—a plan was presented to them, with ample illustrations, explanations and demonstrations of an ærial apparatus, on perfectly rational and established principles, that will evidently navigate the atmosphere at a speed of one hundred miles per hour, with safety, and perfectly at command; being in the form of an *eliptic spindle*, with a buoyancy of several tons, and driven forward by the power of steam, applied to revolving, spiral fan-wheels. Why then, it may be asked, has this *new plan* produced so much excitement, amongst the very people who appeared totally indifferent to the *rational* plan? The answer is, simply, that the scientific plan was introduced by an American, while the new apparatus was invented by an *Italian* gentlemen.—the audience knowing but little of the merits of either.

With regard to the inventor,—Signor Muzzi,—he appears to be an unasuming gentlemen, desirous of procuring assistance to put his invention in successful operation on a large scale. In this we may well sympathize with him, and heartily with him all possible success; but we should be glad to

have our citizens of scientific pretensions, become better informed in the principles of natural philosophy, than they have manifested on this occasion."

It is a fact, the most astonishing and unaccountable fact that is known to exist, that the masses of otherwise intelligent men, persist in downright ignorance of even the main and general principles of natural philosophy; but thus it is, and hence arises the grand difficulty which inventors have to encounter in introducing the most useful and important inventions, while the most gross and ridiculous humbugs are lauded and patronised, and the explosions thereof are muffled and concealed.

To establish the practicability of ærial locomotion, nothing more is required than the combination of three general and well-established principles: first, that a vessel containing hydrogen gas is buoyant in atmospheric air; second, that a revoloidal spindle of any size may be propelled through the air at a rapid rate, without any considerable atmospheric resistance; and third, that a spiral fan-wheel or screw propeller will effect a propulsive power by action on atmospheric air.

It is a very easy thing for wise men, or even reputed scientific men, to shake their heads with the exclamation—"moonshine!" but it is a notorious fact, that the scientific men of New York and of the world have been repeatedly challenged to produce any argument or reason against the feasibility of the plan herein proposed and described. But, hitherto, no person has attempted a scientific refutation, though many are ready enough to denounce this plan as impracticable, because it has not been done before.

It has been generally well known that hydrogen gas, being much lighter, has a buoyant power in atmospheric air; and that the figure known geometrically as the *revoloidal spindle*, will encounter less resistance in passing through the air than either a ball or a cylinder; but it has not been known to what extent, or in what

proportion this difference exists. It is demonstrable however, that a revoloidal spindle, whose length is equal to sixteen times its diameter, will encounter, in passing through the air, less than 1–3000th part of the atmospheric resistance that would be encountered by a cylinder of equal diameter, and running with equal velocity. With regard to the atmospheric resistance encountered by a plain surface passing rapidly through the air, different authors disagree, but we admit it to be equal to 32lbs per square foot of surface moving at the rate of 100 miles per hour, or 146 feet per second. Of course, the resistance encountered by the end of a cylinder 50 feet in diameter, and moving with that velocity, would be 62,000lbs. But we shall show that the resistance encountered by a revoloidal spindle of equal diameter and moving with equal velocity, is less than 20lbs. It is a well-known law of nature, that the resistance of a fluid is as the square of the velocity of the moving body passing through it; and the resistance is increased or diminished as the square of the increase or diminution of the velocity. Therefore, if the velocity is reduced from 146 to 73 feet per second, the resistance is reduced from 32 to 8lbs per square foot. If the velocity is 37 feet, the resistance is only 2lbs. By the same rule, if the velocity is 9 feet, the resistance is only .125; and if the velocity is 4.5 feet, the resistance is only .031 of 1lb per square foot. By the motion of a revoloidal spindle through the atmosphere, the air is removed, not in the direction of the motion of the spindle, but in a direction at right angles with the surface thereof. And, it may be observed, by examining the surface of a spindle of the above-mentioned proportions, that the average velocity with which the air is put in motion, by the passage of the spindle, is only about 1–30th of the velocity of the spindle in its course; so that, if the spindle is moving at the rate of 100 miles per hour, the motion of the removed air is only about 5 feet per se-

cond, and its resistance is consequently less than one thirtieth of a pound per square foot. And this resistance, being not counter to the motion of the spindle, but at right angles to the surface thereof; the entire resistance to the motion of the spindle is only equal to 1–30th of a pound per square foot of the area of the spindle, which being 1900 feet, the entire resistance, even by this rule, would be but 66lbs. But even this resistance is greatly reduced by the elasticy of the atmosphere, and by the excessive pressure of the atmosphere in proportion to the weight or gravity of the air. The weight of air is but little more than one ounce per cubic foot, while the atmospheric pressure is upwards of 2000lbs upon every square foot of surface. This circumstance, in connexion with the well known elasticity of the air, renders it evident that the atmospheric pressure upon the rear half of the spindle is very nearly equal to that on the forward half—the difference is inappreciable. Was the body of air which is removed by the spindle suddenly encountered thereby, and put in motion at the rate of five feet per second (as would be the case if encountered by a wedge shaped figure), and as suddenly returned to its former position, the resistance would be more considerable; but the spindle being pointed, a small portion of surface first produces a very slight motion in the surrounding air, which motion is gradually increased till its velocity reaches 5 feet per second; and is then brought to rest, and as gradually returned to its former position: and it yet remains doubtful whether any difference could be detected between the atmospheric pressure on the forward part of the spindle and that on the rearward part. Was air non-elastic, like water, so that a large body of it was required to be removed, or did it depend on its own gravity to return to its original position when the swelled centre of the spindle had passed, the case would be different. But it is obvious that, by the elasticity of

the air and the atmospheric pressure combined, the air will continue its pressure against all parts of the surface of the spindle equally, or nearly so ; and, consequently, the actual resistance to the forward motion of the spindle must be trivial, probably not exceeding 10lbs with a velocity of 100 miles per hour.

A revoloidal spindle 800 feet long, and 50 feet in diameter, contains 838,000 cubic feet, and being inflated with hydrogen gas, the weight of which is 36 grs. per cubic foot, while that of atmospheric air is 527 grains, its buoyant power in air would be 56,000lbs. Measures being now in progress for constructing such a spindle, or ærial float, we shall proceed to describe it.

Twenty-four spruce rods are to be employed, each rod being an inch and a half in diameter and 800 feet long. These rods are united at each end, and the central parts are bent outward, so as to form the skeleton or frame work of a spindle of 50 feet in diameter, and this frame is covered with cloth coated with gum elastic (India rubber). The rods are six feet apart at the centres, and the cloth is attached to each. A saloon, 180 feet long and 10 feet square at the centre, tapering to a point at each end, is suspended by flattened steel wires about 60 feet below the float. This saloon is made of painted cloth, supported by a very light frame work, and about 80 feet of the central part is furnished with windows, and a floor of thin boards sustained by four rows of vertical wires extending upward to the float. The saloon is also furnished with seats, which may be readily transformed to beds for those who may have occasion to sleep on board. In the centre of the saloon is an apartment 6 feet by 12, in which are adjusted six light tubular boilers of two horse-powers each, and two steam engines, the power of which is applied to two fan wheels or propellers mounted between the float and the saloon. The smoke from the engine fires is conducted 100 feet or more to the rear by a horizontal

pipe. The boilers and engines are supported by strips of steel plate the tops of which are attached to the rods of the float at several different points. Near the engine room is an aperture four feet wide and eight feet long through the floor of the saloon; and this aperture is closed by an elevator, consisting of a platform furnished with seats and railings, and suspended by ropes attached to its four corners. These ropes meet and are united in one about ten feet above the elevator, and this one rope passes over a pulley, and thence to a windlass shaft furnished with cranks and ratchets, and which may be connected to one of the steam engines. One of the rachets serves as an escapement wheel and has a balance verge, so adjusted that the elevator can never descend rapidly; and the elevator is furnished with a small cord, one end of which is attached to the balance verge, so that any person descending by the elevator can instantly stop or check its descent whenever occasion requires. The elevator is drawn up either by the cranks or by steam power.

To the rear end of the float is connected, by a ball and socket or universal joint, a rudder 20 feet long and having four leaves, two of them horizontal and two vertical, each leaf being five feet wide, and consisting of thin boards or sheets of wood, projecting obliquely from a centre bar, and each board tapering from a quarter to a sixteenth of an inch in thickness. From the outward edge of each of the four leaves, a cord extends forward, passing over a pulley, and thence down to the saloon; so that the helmsman can change the position of the rudder, either vertically or horizontally, as occasion may require. It will be readily understood that the machine (which, for want of a better name, is called an ÆRIAL LOCOMOTIVE), may bc made to ascend or descend, as well as to change it horizontal direction, by means of this rudder.

To each of the twenty-four rods within the float is

attached a small cord, and the 24 cords meet at the centre of the float, and passing over twenty-four pulleys, unite in one rope, which after extending a few feet horizontally, passes over another pulley downward, and is connected to a small iron rod, which passes down through a stuffing box in the bottom of the float, and is connected to another rope which extends down to a crank windlass within the saloon; so that by turning the windlass, the entire series of rods are drawn centreward, and the volume of the float may be compressed, and its buoyancy sufficiently reduced to cause it to descend. A compression of a single inch on all sides is sufficient to reduce the buoyancy 36lbs; and the strength of a man applied one minute to the crank is sufficient to reduce the buoyancy 200lbs. These contracting lines may be arranged at several different points in the length of the float, and managed by two vertical contracting rods and two windlass cranks; so that either the forward or rearward part of the float may be compressed occasionally, by which the opposite end will become distended. This arrangement will sometimes be useful in keeping the float in horizontal trim.

The two propelling wheels are each 20 feet in diameter, having eight arms, and to each is attatched an oblique sail seven feet wide at the outward end and eight feet long: the whole presenting about 700 square feet of surface. These wheels will make 200 revolutions per minute, in order to propel the locomotive 100 miles per hour.

It has been before stated that the buoyant power of the float is 56,000lbs. We shall now proceed to a careful estimate of the quantity and weight of all the materials employed in the construction of the apparatus.

20,000 feet of spruce rods, equal to 2000 feet	LBS.
board measure, estimated at 2lbs per foot,	4000
8,000 yards of vulcanized cloth, at ½lb per yard	4000
800 feet of ½ inch boards for floor of saloon, .	800

300 yards painted cloth for saloon, . . .	150
12,000 feet of cast steel wire	300
Seats and furniture	500
Six boilers and two engines	2000
Two propelling wheels	500
Fuel and water for 12 hours	1000
Rudder and ropes	450
Sundries, overlooked in the above estimate .	300
Total weight, ...	14,000

Leaving a balance of buoyancy of 42,000lbs, sufficient for 200 passengers and their baggage.

To show the advantage of a machine of the foregoing dimensions over one of a smaller size, we subjoin an estimate of one of half the diameter and one-fourth of the length of the above-described.

Length, 200 feet; diameter, 25 feet; contents 52,370 cubic feet; buoyancy, 3,500lbs.

Weight of 800 yards of cloth	400
2,400 feet of rods	400
Cloth for saloon (50 long, 6 diameter) 74 yards	37
Floor of saloon, 150 feet of thin boards .	150
Suspending wires 3,000 feet	63
Propelling wheels	150
Rudder, ropes, and belts	60
Total weight without an engine,	12,60

Leaving a balance of buoyancy of 2,240lbs.

A four-horse power engine	700
Water and fuel	400
Total weight	23,60

Balance of buoyancy 1,140lbs, sufficient for five persons with baggage, &c.

The atmospheric resistance against a float of this small size and proportion, is as great as that encountered by the large one.

The estimated cost of an ærial locomotive of the small size, is as follows:—

Cloth for the float, 50 cents per yard . .	$400
Longitudinal rods	10
Laber in making the float	100
Rudder and its rigging	10
Cost of inflation with zinc hydrogen . . .	500
Cost of saloon, including materials . .	50
Cost of wires and wheels	100
Engine four-horse power and belt chains .	500
Elevator, seats and other items	30
Total cost . .	$1,700

If inflated with hydrogen produced by a solution of iron, the cost will be $350 less; and if the engine is omitted, the cost will be but $850.

While on the subject of estimates, we will give those of the smallest and cheapest æriel locomotive that it is practicable to construct and navigate, propelling it by a crank.

Length, 120 feet; diameter, 20 feet; contents, 20,000 cubic feet; buoyant power, 1,300lbs.

Materials.	*Weight.*	*Cost.*
Cloth for the float—400 yards .	200lbs.	$200
1,200 feet of rods	200	10
Saloon, 25 feet long	200	50
Connecting wires and rudder . .	100	50
Propelling wheels	100	30
Labor in making the float		50
Cost of inflation		110
Total weight and cost,	800lbs.	$500

Balance of buoyancy—500lbs.

To return to the subject of the large locomotive:— It is obvious that no part of the cloth of the float can be subject to a greater pressure than 28 ounces per square foot; for the entire buoyancy of a column of

hydrogen one foot square and fifty feet high, can no exceed 53 onces, and this upward force is equally divided between the pressure of the gas upward against the top and the pressure of the air upward against the bottomof the float. The longitudinal rods are but six feet apart, and it may be readily proved by trial that a strip of light vulcanized cloth one foot wide and six feet long, being confined at the ends, will sustain at least four times the weight above mentioned. With regard to the weight of the saloon and its contents, one half thereof must be sustained by the cloth, which constitutes the right and left sides of the float. The weight to be thus sustained is about 20,000 pounds, and this weight is sustained by 1600 feet of cloth,—a little more than 12 pounds per foot; yet it is well known that each foot of the cloth will sustain upwards of 100 pounds.

With regard to safety, there appears to be less danger of any accident to the float, than to the hull of even a marine sailing vessel. The float is to be constructed with several appartments, so that if a rent should occur in one part it would not occasion a sudden descent. It appears impossible that the float should ever take fire; and if the saloon should take fire, it can be brought to the ground in three minutes from an ordinary height. Moreover, each passenger will be furnished with an improved parachute, by which he can descend from any height without danger. With a parachute eight feet in diameter a man of ordinary weight may descend from any height with less velocity than he would acquire in descending the distance of five feet without it. A gale of wind will not in the least degree affect the float nor the saloon by force or pressure, because the entire apparatus will float with the current; and however strong the wind may be in any direction, the passengers will experience an apparent calm, with the exception of an apparent head wind, produced by the forward motion of the locomotive. A wind that travels 20 miles an hour, is called a fresh sailing breeze; and it is a very severe gale that travels 50 miles per hour; and if, as is expected, the large locomotive is capable of making 100 miles

per hour in a calm, it will be able to stem the current of a 50 mile gale, and make 50 miles per hour to windward. Should such a gale blow transversely to the course, it will be only requisite to change the head of the locomotive about 22 degrees to windward, in order to keep on its course; and the distance lost in consequence will be only abount 10 miles in 100. Whenever it becomes requisite to stop the machine and come to moorings, it is only required to head the float to the wind, and check the motion of the wheels till the locomotive becomes stationary, when a man may descend in the elevator and secure a small hawser. For this purpose he will be furnished with a large spiral perforator in the form a cork-screw, which he will insert in the earth if there is no permanent object at hand. A large rope is not required to hold the machine, for the severest gale cannot exert a force against it exceeding 50 pounds. In case of the approach of a real tornado, the locomotive may either rise above it and let it pass below, or a grapple may be thrown out by which the machine may be brought to safe moorings. In case of a thunderstorm it will not be possible for the float to be ignited by lightining when thus protected by 200 steel wires; but it may sometimes be requisite to throw out one end of a small copper wire to the earth to discharge electricity from the machine.

The attention of the public is drawn to this subject at present with regard, principally, to the facility thereby furnished, of emigration to California; but we have discovered no apparent difficulty in passing over the Atlantic to London or Paris. The machine will carry, in addition to 100 passengers, a sufficient quantity of fuel to last 48 hours, which will be several hours longer than the time required for the passage, under ordinary circumstances. And as it is well known that different and opposite currents prevail at different heights in the air, the machine may run at such elevations as will be most favorable in this respect, and never be compelled to stem a severe head-wind. With regard to a supply

of water, it may be readily obtained at any time, though it is proposed to condense the escape steam so as to avoid any waste of water; this may be done by means of two long horrizontal pipes exposed to the current of air only. Hydrogen gas is to be constantly supplied by a proper apparatus on board for that purpose.

It may be anticipated that within a few months these ærial machines may be seen soaring in various directions and at different elevations, some apparently among or above the clouds, and others, like swallows, sailing leisurly just above the surface of the earth. The sides of the most lofty and rugged mountains, and the fertile valleys will be alike reconoitred. Let our gentle readers imagine themselves to be visiting the pleasant and excellent literary establishment on the summit of Mount Holyoke on a sunny morning in the balmy month of June, and gently descending thence towards the verdant plains which border the meandering Connecticut, and then at an elevation of only 8 or 10 feet from the ground sailing moderately over the rich fields of broom and grain; and over the flower spangled fields of grass, waiving to the western breeze, and conversing by the way with the merry farmers, as they follow their recreative avocation of hay-making; then ascending with accelerated velocity to the altitude of refreshing temperature and returning to New-York to dine. Or suppose yourselves leisurely cruizing along by the steep and rugged sides of the Rocky Mountains, and laughing at the astonished countenance of the harmless grizzly bear, or at the agility of the frightened antelope; and then descending to the extensive praries to watch the prancing of the wild horses, or the furious rushing of hordes of Buffaloes. These things are indeed but fancies at present, but in a few months these fancies may become pleasant realities in America, while the proud nations of Europe are staring and wondering at the soaring enterprize of the independent citizens of the United States.

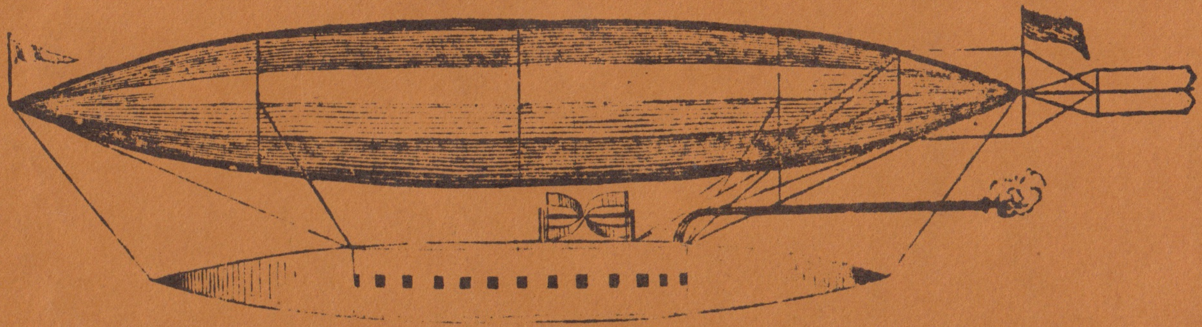


DIAGRAM OF THE AERIAL LOCOMOTIVE.